

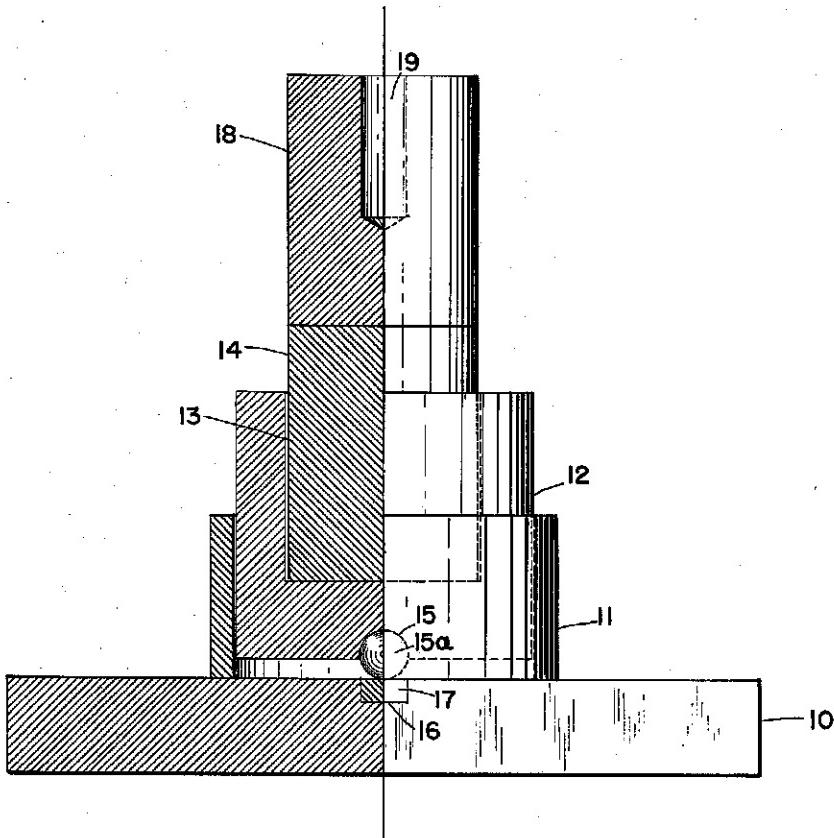
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STABILIZED EXPLOSIVE CONTAINING NITROMETHANE AND AMINE

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STABILIZED EXPLOSIVE CONTAINING  
NITROMETHANE AND AMINE

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This invention is concerned with high explosives, i.e. explosives having a velocity of detonation in excess of 2000 meters per second, and provides a novel high explosive which is more powerful than many heretofore customary examples and at the same time more stable and less likely to be detonated by substantial shock or jar. More specifically my invention contemplates a high explosive of nitro-methane base which detonates more rapidly and with greater force than such well-known types as trinitrotoluene and nitroglycerine, and which may be handled, stored and shipped with as high a degree of safety as ordinary inflammables such as gasoline, toluene and benzene.

A number of explosives with a high velocity of detonation and of great explosive power are known, but many of these are so inherently unstable that they cannot be handled safely even when extreme precautions are taken to avoid shocks and jars, so that their application has been much limited.

In consequence, usable examples of high explosives are relatively few and in the main are those which do not have the tremendous shattering effect of the less stable types.

As a result of my investigation I have developed a high explosive of nitromethane base which couples desired stability, high detonation rate and high explosive force. The term "nitromethane" is used herein to designate mono-nitromethane. Similarly, the term "nitroethane" is employed to designate mononitroethane.

Nitromethane, although a known explosive, can be detonated only with difficulty and explosion is propagated through its mass only if the force of detonation is high and the charge is strongly confined. For example, detonation can be propagated only with great difficulty, if at all, throughout a charge of nitromethane in an open thin-walled container. On the other hand, nitromethane has high shock resistance at ordinary temperatures and cannot be detonated by mild shocks or jars, although I have discovered that the addition to a nitromethane base of an organic amine which is miscible with the base and is sufficiently basic to form salts of weak acids (either organic or inorganic) results in a product of high stability, but which has extreme explosive force and a high velocity of detonation.

By nitromethane base explosive, I mean a mixture in which a major explosive ingredient is nitromethane. I have found that nitromethane per se when mixed with a suitable amine provides a superior explosive composition, but have also discovered that the nitromethane may be used in conjunction with other explosive ingredients and diluents. For example up to 30% by volume of nitroethane, or up to 15% of nitropropane may be added to the nitromethane.

Moreover, conventional solid diluents or fillers such as sawdust or diatomaceous earth may be used, and in some instances the incorporation of liquid diluents such as alcohol or benzene may be used to inhibit explosive character.

The organic amine may be either aliphatic or aromatic in character and may be employed advantageously in proportions ranging up to 40% by volume of the nitromethane, although in proportions much exceeding 3% the law of diminishing returns applies.

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As indicated above it appears that substantially any organic amine or miscible mixtures of such amines are suitable for the practice of the invention, provided

(a) That the amine or amine mixture is miscible with the balance of the explosive so that it does not segregate substantially therein; and

(b) That the amine or amine mixture is sufficiently basic to form salts with weak acids (either organic or inorganic), for example such acids as phosphoric, acetic, carbonic, sulphurous and nitrous, these being "weak acids" within the meaning of this specification and claims.

The amines having the above qualifications may be selected from either the aliphatic or aromatic groups. Examples of suitable organic amines found particularly satisfactory are:

In the aromatic group, aniline, diphenylethylenediamine and phenylbetanaphthylamine;

In the aliphatic group, diethylamine, tetraethylene pentamine, and morpholine.

The aliphatic amines, particularly diethylamine, have been found to be especially effective. These amines have a phenomenal effect of increasing enormously the explosive power of nitromethane. Small percentages of any of these amines, around 2% by volume, when added to the nitromethane produce an explosive which is sensitive enough to be detonated by a standard No. 8 blasting cap even though the material is placed in an open thin-walled container. Such a mixture of amine-nitromethane will propagate the explosion through the liquid even when placed in thin-walled containers such as light metal tubing or pipe.

When nitromethane is detonated it appears to possess explosive properties which are comparable to trinitrotoluene, nitromethane having a higher velocity of detonation and higher brisance than has been observed when an equivalent charge of trinitrotoluene is exploded. The effectiveness of the amine-nitromethane mixtures is clearly demonstrated by comparative tests in which trinitrotoluene is employed as a standard. All of these tests demonstrate that there is a great increase in the explosive power of these mixtures over that of trinitrotoluene.

The addition of approximately 2% by volume of any of the above amines to nitromethane appears sufficient to release a large proportion of the total energy of the nitromethane when the mixture is detonated. The percentages of amine which will produce this desired result vary from a trace to about 40% by volume of the amine.

A comparison of the explosive strengths of these nitromethane-amine mixtures has been made and compared with the explosive strength of an equivalent amount of trinitrotoluene. Tests were conducted employing a modified version of the Trauzl lead block expansion test.

The test is conducted briefly as follows: A solid lead cylinder 200 mm. in height and 200 mm. in diameter is bored with an axial hole in one end which is 25 mm. diameter and 125 mm. deep. When the routine manner of conducting the test is followed, 10 grams of the explosive to be tested are placed in the axial hole and a detonating cap is immersed in the explosive. It is customary to pack sand into the open end of the axial hole after the explosive and the cap have been introduced into the hole. The lead blocks are then allowed to reach room temperature (15° to 20° C.) before the charge is fired. In conducting my investigation the Trauzl test was modified so that 15 grams of the explosive mixture were employed in place of the customary 10 gram charge. The use of 15 gram charges is desirable to insure a sufficient depth of liquid or explosive so as to enable the explosive to cover a No. 8 blasting cap. The following results demonstrate the difference in explosive violence between

the trinitrotoluene and some of the amine-nitromethane mixtures.

Test No.	Test Sample	Volume of Cavity(cc.)			Percent Increase
		Original	After firing	Increase	
1.	15 gr. trinitrotoluene	65	362	297	460
2.	15 gr. nitromethane 97%, diethylamine 3%	65	462	397	610
3.	15 gr. nitromethane 98%, diethylamine 2%	65	510	445	680

A cross section view taken through the center of the lead blocks after the explosion, strikingly brings out the difference between the action of the various explosives. Trinitrotoluene produces a pear-shaped cavity showing some enlargement of the upper end of the bored hole, whereas a nitromethane-amine mixture produces a nearly spherical cavity showing very little increase in the upper portion of the bore. This appears to indicate that the detonating velocity of the nitromethane-amine mixture is higher than the detonating velocity of trinitrotoluene.

The relative force of the explosion as produced by the various mixtures may be compared to trinitrotoluene by means of a Brinell type of apparatus. This test will be more easily understood with reference to the accompanying drawing which shows the Brinell type of apparatus that was employed in obtaining these data.

Referring to the figure a base 10 is provided with an annular collar 11 which is firmly attached to the base. A cylindrical block 12 is machined so that it fits loosely into an annular collar 11 and is axially drilled for a suitable distance by a bore 13 to fit a second solid cylindrical block 14. The bottom of the block 12 is machined so that it has a central hemispherical depression 15 suitable for seating a  $\frac{3}{4}$ " hardened steel ball bearing 15a. The base 10 is slotted with a rectangular depression 16 into which a mild steel bar 17 is placed. The ball 15a is so placed that it rests centrally on the surface of the mild steel bar 17. A firing block 18 of the same diameter as the second solid cylindrical block 14 is placed upon the top of the cylinder 14. An axial hole 19 is drilled into the firing block 18 and extends a substantial distance into the block. 17.2 grams of the explosive to be tested are placed in bore 19 and a No. 8 detonating cap, which is preferably fired by electrical contact, is submerged in the explosive. When the charge is fired a portion of the force exerted by the explosion is in a downward direction and the effect of this downward force is measured by the size of the indentation made by the hardened steel ball 15a on the mild steel bar 17. It is desirable to employ the solid cylinder 14 between the cylinder 12 and the cylinder 18 because the explosives which are the subject of my invention usually shatter the testing cylinder 18 into small fragments. Hence, unless some means were taken to protect the block 12 from the bursting force of the explosion no positive indication could be obtained of the effective downward force of the explosion in the cylinder 18.

While this apparatus attempts to record the downward thrust of the explosion occurring in the thick-walled cylinder it must be remembered that the results obtained are not indicative of the total force generated by the explosion of the mixture since a large portion of the force generated by the nitromethane-amine mixture is apparently employed in bursting the steel cylinders. Trinitrotoluene usually causes deformation of the test cylinder 18 but does not break it up in small fragments. The test gives, however, some indication of the comparative force of the various nitro-methane-amine explosive mixtures with respect to trinitrotoluene.

The following is a tabulation of the comparative results obtained by this test method. In performing the following test 17.2 grams of samples were used in each case.

The indentation caused by exploding trinitrotoluene is used as a standard of comparison.

Mixture explosive:	Average diameter—in inches
Trinitrotoluene	.25
Nitromethane	.22
Nitromethane + 2% aniline	.37
Nitromethane + 4% aniline	.37
Nitromethane + 6% aniline	.37
Nitromethane + 2% diethylamine	.385
Nitromethane + 4% diethylamine	.37
Nitromethane + 6% diethylamine	.36
Nitromethane + 2% tetraethylene-pentamine	.40

Nitromethane + 4% tetraethylene-pentamine	.36
Nitromethane + 6% tetraethylene-pentamine	.34
Nitromethane + 2% morpholine	.39
Nitromethane + 4% morpholine	.37

As noted above all of the mixtures of nitromethane plus an amine ruptured the test cylinder when exploded. Therefore, the above results for the nitromethane-amine mixture are only approximate and probably low.

It has been observed that when higher percentages than 2% - 3%, by weight, of the amines are added to the explosive mixture the force of the mixture becomes slightly lower. This fact is probably due to the dilution of the explosive ingredients. Even when traces of the amines mentioned above were added to nitromethane they appreciably increased its sensitivity to detonation.

Test mixtures employing diethylamine, morpholine, tetraethylene-pentamine in percentages varying from 1% to 45% of the amine by volume have been tried and all of these mixtures detonate violently. When, however, the percentage of aliphatic amines was increased above 45% of the mixture detonation failures have occurred.

As I have already indicated when mixtures of nitromethane and the above-listed amines are employed, limited

amounts of other nitroparaffins, such as nitroethane and nitropropane, may be added to the nitromethane. The resulting mixtures have also been made to explode violently in open thin-walled containers when exposed to the shock of a No. 8 blasting cap. For example, as high as 30% by volume of the nitroethane may be employed in a mixture containing 3% tetraethylene-pentamine and 67% nitromethane by volume before any failure in detonation occurs. 2-nitropropane may be substituted in place of the nitroethane and this mixture will also explode in open thin-walled containers from the shock of a No. 8 blasting cap. However, the amount of nitropropane which may be employed before detonation failures will result is considerably less than the amount of nitroethane. For example, it has been observed that 15% by volume of nitropropane mixed with 3% tetraethylene-pentamine and 82% nitromethane will detonate, whereas, a mixture containing an amount greater than 15% by volume of nitropropane detonates with great difficulty, if at all.

It has been observed that those mixtures in which a portion of the nitromethane is replaced by nitroethane or nitropropane do not appear to exhibit any more explosive power than the amine-nitromethane mixtures and produce a considerably more visible flame when exploded.

The amine-nitromethane mixtures listed above are, as compared to other high explosives, relatively insensitive to any ordinary shock. A No. 8 blasting cap partially submerged in a 4% aniline-nitromethane mixture failed to detonate the mixture. Likewise the amine-nitromethane mixtures cannot be detonated readily by a nearby violent explosion of the same mixture. These amine-nitromethane explosives appear to be very stable and do not lose their explosive properties on relatively substantial aging or heating to the boiling point. At somewhat higher temperatures than atmospheric the sensitivity of the

mixtures increases slightly but the explosive power of the mixture is not appreciably affected in any manner.

An outstanding advantage of my explosive resides in the fact that the ingredients may be either mixed beforehand and transported to the place where they are to be used, or the relatively stable components may be transported to the desired locality and mixed shortly before they are to be employed. This relative freedom from shock sensitivity coupled with the extremely high explosive power when the mixture is detonated, produces an explosive compound which may be employed under all types of adverse conditions without subjecting the operator to undue hazards of premature explosions.

Another advantage is that the nitromethane may contain some water without noticeably affecting the explosive properties of the amine-nitromethane mixtures.

I claim:

1. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2%–3% by volume of diethylamine based on the volume of the nitromethane.

2. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of tetraethylenepentamine based on the volume of the nitromethane.

3. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of morpholine based on the volume of the nitromethane.

4. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of aniline based on the volume of the nitromethane.

5. An explosive composition consisting of a mixture of mononitromethane sensitized with 2% by volume of diphenylethylenediamine based on the volume of the nitromethane.

6. An explosive composition consisting of a mixture of mononitromethane sensitized with 2% by volume of phenylbetanaphthylamine based on the volume of the nitromethane.

7. An explosive composition consisting of a mixture of mononitromethane sensitized with from a trace to about 40% by volume of the amines from the group consisting of aniline, diphenylethylenediamine, phenylbetanaphthylamine, diethylamine, tetraethylene pentamine and morpholine, based on the volume of the mononitromethane.

8. An explosive composition consisting of a mixture of mononitromethane sensitized with from 2 to 3% by volume of the amines from the group consisting of aniline, diphenylethylenediamine, phenylbetanaphthylamine, di-

ethylamine, tetraethylene pentamine and morpholine, based on the volume of the mononitromethane.

9. An explosive consisting of 97% by weight of mononitromethane and 3% by weight of aniline.

10. An explosive consisting of a predominant proportion of mononitromethane and a minor proportion of morpholine.

11. An explosive consisting of a predominate proportion of mononitromethane and a minor proportion of an organic amine which is miscible with the mononitromethane and is sufficiently basic to react with weak acids.

12. An explosive consisting of mononitromethane and an organic amine in proportions ranging from a trace to 40% by volume of the mononitromethane, the amine being miscible with the remainder of the explosive and sufficiently basic to form salts with weak acids.

13. An explosive according to claim 12 in which the amine is an aromatic compound.

14. An explosive according to claim 12 in which the amine is an aliphatic compound.

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